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14. ABSTRACT Inattentional Blindness is the human condition of not perceiving an event that is rare or unexpected, even though it is in full view. This research tests the hypothesis that inattentional blindness to rare events can be lessened by increasing the frequency of rare events (thus making the events less rare). Our test domain is security. We videotaped actors in a building, and java-coded a test instrument simulating a contemporary multi-frame surveillance camera with a controls to allow response to on-screen events. We found that inattentional blindness					
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Report Title

Spot rare occurrences more frequently by lessening inattentional blindness

ABSTRACT

Inattentional Blindness is the human condition of not perceiving an event that is rare or unexpected, even though it is in full view. This research tests the hypothesis that inattentional blindness to rare events can be lessened by increasing the frequency of rare events (thus making the events less rare). Our test domain is security. We videotaped actors in a building, and java-coded a test instrument simulating a contemporary multi-frame surveillance camera with a controls to allow response to on-screen events. We found that inattentional blindness dropped between the control group and the group with the maximum number of surprise events, although the number of false positives detected rose also. We found that additional thought time allotted to each surprise event did not lower inattentional blindness, but increasing the number of surprise events to attend to lowered main task performance somewhat. We did not find a correlation between individual differences such as age or gender and inattentional blindness level, nor did we find a correlation with the previous night's sleep. However, we did find a correlation between inattentional blindness and the location of the event on the viewing monitor.

Enter List of papers submitted or published that acknowledge ARO support from the start of the project to the date of this printing. List the papers, including journal references, in the following categories:

(a) Papers published in peer-reviewed journals (N/A for none)

Received

Paper

TOTAL:

Number of Papers published in peer-reviewed journals:

(b) Papers published in non-peer-reviewed journals (N/A for none)

Received

Paper

TOTAL:

Number of Papers published in non peer-reviewed journals:

(c) Presentations

Research findings will be presented at a talk to the department faculty on May 14, 2013.

Number of Presentations: 0.00

Non Peer-Reviewed Conference Proceeding publications (other than abstracts):

Received Paper

TOTAL:

Number of Non Peer-Reviewed Conference Proceeding publications (other than abstracts):

Peer-Reviewed Conference Proceeding publications (other than abstracts):

Received Paper

TOTAL:

Number of Peer-Reviewed Conference Proceeding publications (other than abstracts):

(d) Manuscripts

Received Paper

04/04/2013	2.00	Judith Gelernter. Spot Rare Occurrences More Frequently by Lessening Inattentional Blindness, ACM Transactions on Applied Perception (03 2013)
04/04/2013	1.00	Judith Gelernter. How can we measure and correct for inattentional blindness? , Attention, Perception, & Psychophysics (04 2013)
04/24/2013	3.00	Judith Gelernter. Computer simulations can lessen “overlook” mistakes due to inattentional blindness, ACM Transactions on Applied Perception (04 2013)

TOTAL: 3

Number of Manuscripts:

Books

Received

Paper

TOTAL:

Patents Submitted

Patents Awarded

Awards

Graduate Students

<u>NAME</u>	<u>PERCENT SUPPORTED</u>	Discipline
Cong Lu	0.03	
Wei Zhang	0.15	
Apoorvi Jain	0.14	
FTE Equivalent:	0.32	
Total Number:	3	

Names of Post Doctorates

<u>NAME</u>	<u>PERCENT SUPPORTED</u>
FTE Equivalent:	
Total Number:	

Names of Faculty Supported

<u>NAME</u>	<u>PERCENT SUPPORTED</u>	National Academy Member
Judith Gelernter	0.62	No
FTE Equivalent:	0.62	
Total Number:	1	

Names of Under Graduate students supported

<u>NAME</u>	<u>PERCENT SUPPORTED</u>	Discipline
Sally Gao	0.13	Computer Science
Shilpa Balaji	0.01	Computer Science
FTE Equivalent:	0.14	
Total Number:	2	

Student Metrics

This section only applies to graduating undergraduates supported by this agreement in this reporting period

The number of undergraduates funded by this agreement who graduated during this period:	1.00
The number of undergraduates funded by this agreement who graduated during this period with a degree in science, mathematics, engineering, or technology fields:.....	1.00
The number of undergraduates funded by your agreement who graduated during this period and will continue to pursue a graduate or Ph.D. degree in science, mathematics, engineering, or technology fields:.....	0.00
Number of graduating undergraduates who achieved a 3.5 GPA to 4.0 (4.0 max scale):	1.00
Number of graduating undergraduates funded by a DoD funded Center of Excellence grant for Education, Research and Engineering:.....	0.00
The number of undergraduates funded by your agreement who graduated during this period and intend to work for the Department of Defense	0.00
The number of undergraduates funded by your agreement who graduated during this period and will receive scholarships or fellowships for further studies in science, mathematics, engineering or technology fields:	0.00

Names of Personnel receiving masters degrees

NAME

Total Number:

Names of personnel receiving PhDs

NAME

Total Number:

Names of other research staff

NAME

PERCENT SUPPORTED

FTE Equivalent:

Total Number:

Sub Contractors (DD882)

Inventions (DD882)

Scientific Progress

Foreword

“Inattentional blindness” is a lack of attention to an event, of which one by-product is not seeing that event. Not noticing events is a cause of mistakes such as letting a person with weapon slip through airport security, not hearing a siren when driving conditions are complicated by fog, or not seeing explosives on a truck crossing the border. Mitigating mistakes from inattentional blindness therefore would be helpful to individuals as well as for national security.

Two papers resulted from our inquiry into inattentional blindness in the domain of security. We have written a methods paper (“How can we measure and correct for inattentional blindness to lessen human mistakes?”) that postulates an approach to inattentional blindness more consonant with human attention than many of those common in laboratory testing, and a findings paper (“Computer simulations can lessen inattentional blindness”) that discusses results of our inattentional blindness experiment and proposes a system to lessen inattentional blindness in the workplace.

Findings from this paper lend insight into why current threat image projection software used in airport screening is not effective. We suggest what to do to improve its effectiveness, postulate related lines of software for building security and for the medical domain intended to lower “overlook” mistakes due to inattentional blindness.

Illustrations list

Table: “Hypotheses and Findings” based on the findings paper

Problems studied

We studied the effects and interactions of an array of factors to determine whether they affect inattentional blindness.

Addressed in the methods paper:

- (1) How can we test for inattentional blindness with an experiment of a duration that allows for natural human attention fluctuation?
- (2) Can we create a system (in the security domain) that allows us to measure inattentional blindness?
- (3) In a laboratory setting, is it necessary to mask the ‘inattentional blindness’ search object or event by not telling participants what they ought to be looking for?

Addressed in the findings paper:

- (4) Are we able to bring an event from transient into working memory to make it “reportable” by increasing the event frequency?
- (5) Does increasing the frequency of surprise events
 - a. decrease the level of inattentional blindness toward similar surprise events?
 - b. increase the level of false positives in surprise event detection?
 - c. affect the performance at the task the occupies the main attention?
- (6) Is inattentional blindness affected by gender or age?
- (7) Is inattentional blindness affected by factors that affect attention generally, such as lack of sleep, or by factors that affect vision generally such as screen location?
- (8) Are people aware of their level of inattentional blindness, or does perception differ substantially from their level of inattentional blindness as reflected by their performance?

Important accomplishments

Paper_1: Methods

Inattentional blindness in the field and inattentional blindness testing

The prevailing method resembles vision testing in that experiments that are short, one-trial instances which either the participant sees or not. Inattentional blindness however, is about attention, and in fact, it has been found to confound the sense of hearing as well as vision). Attention fluctuates regardless of whether the person knows what he should be looking for or not. We know this from accounts of inattentional blindness in a professional setting, whether it is airport screeners checking travellers’ luggage for explosive materials (Hallinan, 2009), or looking at the road when driving and not seeing (Hallinan, 2009), or determining what drugs should be administered to patients (Watson, 2010).

Our method for testing inattentional blindness is novel in that it of two-hours in duration, includes numerous instances of inattentional blindness, and alerts participants as to the nature of the secondary identification task (subject to inattentional blindness) as well as the nature of the primary task. This method for testing resembles in the field instances of inattentional blindness, making our results potentially valid in a real-world setting.

Novel system and instrument to test for inattentional blindness

We created an instrument for testing inattentional blindness in the security domain with the support of a Berkman Faculty Development grant. That instrument resembles state-of-the-art surveillance systems in its four-quadrant color layout with many building angles that change every few minutes. We hired actors and videotaped day-to-day hallway activities, interspersed with

behaviors defined by the U.S. Department of Homeland Security as “suspicious”. The security videos come in three levels of numbers of surprise events. The videos are edited to be the same in almost all detail except the number of surprise and threatening events.

We created a “count and call” input system that allows the participants’ responses to be recorded. The system uses a keyboard tap to record hat-sittings as the primary task, and a mouse click to record threat-sittings as the secondary task. For the experiment, participants were asked to consider themselves to be Building Guards, monitoring hallways during a two hour shift. They were asked primarily to respond to people wearing hats, and remember the look of the hats and where in the building the hat people were. Secondly, and subject to inattention blindness, was their task of spotting the suspicious behaviors we call threats. During the experiment, the system compares the hat and threat inputs from participants to a master index to record whether the participant spotted that hat or threat in the right quadrant at the right time, or not at all.

We ran the threat-spotting as a separate experiment without a main task, to compare to the threat-spotting when it is secondary to another main task. We found that participants identification of threats was greater when it was the only task than when it was the secondary task, thereby demonstrating the construct validity of the instrument and the experimental method.

Contributions

Contributions of this paper are the presentation of cognitively sound method to inattention blindness which is likely to be valid in a workplace setting, and the availability of our set of inattention blindness test instruments to the scientific community for continued testing.

Paper_2: Findings

Science

In brief, an event subject to inattention blindness might be seen but not remembered. One hypothesis is that we can encourage an object or event to be remembered by increasing its frequency of occurrence, or prevalence. This hypothesis has been found by other researchers to be correct (White and Davies 2008), (Wolfe et al, 2005).

Review of the experiment

The hypothesis that increasing rare event frequency improves event spotting has not been tested over a long period of time (our experiment is 2 hours) so that it can modulate to human attention. The primary task is to remember hats people wear and the activities and location in the building of the hat-wearers, as well as to count hat-wearers. The secondary task subject to inattention blindness is spot suspicious behaviors, or threats.

We ran extensive pilot testing to polish the call and count system, the instrument, and the instructions protocol, as well as the exit questions. The actual experiment had 108 participants divided randomly with 36 in group A, 36 in group B, and 36 in group C. 18 of the 36 people in each group were asked to write Incident Reports for each surprise event noticed. The experiment thus had a 3 x 2 factorial design. The groups differed by the number of surprise events they experienced. Group A was the control group with 2 threats, group B had 9 threats—two from A and 7 new ones; and C had 25—the 9 from B and 16 new ones.

Findings

We found that inattention blindness dropped between the control group and the group with the maximum number of surprise events, although at the same time, the performance at the main task dropped somewhat. We found that additional thought time allotted to each surprise event, as in our Incident Report writing, did not lower inattention blindness. Our hypothesis findings are summarized in the result table.

We found that, over the two hours of the experiment, attention waned somewhat, and performance dropped somewhat, probably in consequence. We found that the amount of sleep participants had the night before the experiment did not correlate with their performance. Although it has been shown that sleep affects attention and in fact, decision-making has been shown to drop as a consequence (Fraser et al 2013), we did not find this effect after a single night of poor sleep.

We did not find a correlation between age or gender and inattention blindness level. However, we did find a correlation between inattention blindness and the location of primary and secondary events on the viewing monitor.

We found that participants’ perception of their own attention levels did not correspond to their actual attention levels as demonstrated by their performance. Although participants had a sense of whether their attention level was high or low, their perception turned into numbers and scaled to their performance score did not correlate highly.

Some limitations

Statistically, in cases where there is no effect or where the effect is quite large, the size of the sample is less important than in cases where there is an effect, but that effect is small. The effect might increase were the number of simulated rare events to increase, but this awaits further experimentation.

Remarks on threat image projection software

This approach of projecting simulated threat images onto actual luggage to rare awareness of potential actual threats has been implemented in airport security for several years. The effectiveness of this Threat Image Projection software on screener error has been shown to decline after some months of use, such that covert tests of actual threats were not affected. It is believed that the reason the software becomes ineffective is that threat images are missed because of recognition error rather than attention error, and so if the screeners have better training about what images to expect, the error will go away. Further, it is believed that actual threats are missed by screeners because they have not been seen in simulations, so again, the proposed solution is that the image library of simulated threats should be widened [Schwaninger et al. 2007], [Cutler and Paddock, 2009].

We believe based on our experiment that the reason the threat image projection software becomes less effective over time is that images should be projected far more frequently, and at more random intervals (sometimes close in time and space). Introducing foils, or non-threats, encourages screeners to examine what is projected so that any simulated image would need to be examined carefully. Shorter shifts would also improve threat detection, as we have shown that a person's accuracy declines over a period of a few hours.

Towards effective inattention blindness reduction

Even fewer mistakes would be made if we could set up viewing redundancy. The person examining the monitor need not be on site. Two or more people could simultaneously watch the same monitor, and their independent responses could serve to verify each other. It would be more likely that their individual judgments were correct if they delivered the same response. But if their responses disagreed, an immediate warning could be sent to both to look again, or to the on site person to examine the actual situation more carefully.

Generalizability

The four-panel subdivision of the screen might be equivalent to the use of four separate screens. The difference is that multiple monitors will require more head movement on the part of the user than the subdivided screen in this experiment.

We can generalize the simulation of threats overlying actual data to other domains because the same attention and inattention principles hold. For the medical domain, for example, say that the rare events simulated are tumors. One implementation option would be that simulated tumor slides resembling but not identical to those found in patients would be interspersed randomly among actual patient slides. Thousands of malignancy images could be generated automatically, so that the doctor would not recognize the actual slide, but would recognize only the malignancy. A pathologist or cytologist in cancer screening would not know which slides would not be associated with actual patients until he responded. Responses to these simulated tumors would heighten awareness for actual tumors, so that actual tumors would be less likely to be overlooked.

Future work

Particularly relevant to our research would be to continue experiments to determine the optimal frequency that the surprise events should be sprinkled into a work protocol (whether hourly or daily, for example), to lessen mistakes. Other conditions might be tried in addition to the increased frequency of events, such as psychological or financial incentives.

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Technology Transfer

Independent variable	Dependent variable	Correlation?	Sample size
Increasing number surprise events	Error rate (as number of misses of surprise events)	Y, statistically significant between groups A and C	108
Increasing amount of thought time per surprise event as number of threats increase	Error rate (as number of misses of surprise events)	N	108
Increasing the number of surprise events	Number of false positives in surprise event detection	N	108
Increasing the number of surprise events	Error rate as number of misses in main event detection	Y, statistically significant	108